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Home Security System Based on k-NN Classifier

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Abstract

In this paper we describe a home security system based on k-nn Classifier. Images were taken in uncontrolled indoor environment using video cameras of various qualities. Database contains 4,005 static images (in visible and infrared spectrum) of 267 subjects. Images from different quality cameras should mimic real-world conditions and enable robust face recognition algorithms testing, emphasizing different law enforcement and surveillance use case scenarios. In addition to database description, this paper also elaborates on possible uses of the database and proposes a testing protocol. A baseline Principal Component Analysis (PCA) face recognition algorithm was tested following the proposed protocol based on k-nn Classifier. Other researchers can use these test results as a control algorithm performance score when testing their own algorithms on this dataset. Database is available to research community through the procedure described at http://www.lrv.fri.uni-lj.si/facedb.html.

Keywords: Home Security, Face Database, k-NN Classifier

1. Introduction

The current evolution of computer technologies has envisaged an advanced machinery world, where human life is enhanced by artificial intelligence. Indeed, this trend has already prompted an active development in machine intelligence. Computer vision, for example, aims to duplicate human vision. Traditionally, computer vision systems have been used in specific tasks such as performing tedious and repetitive visual tasks of assembly line inspection. Current development in this area is moving toward more generalized vision applications such as face recognition and video coding techniques [1].

The field of face detection has made significant progress in the past decade. In particular, the seminal work by Viola and Jones [2] has made face detection practically feasible in real world applications such as digital cameras and photo organization software. In this report, we present a security system based on k-nn Classifier. More attention will be given to PCA based face detection schemes, which have evolved as the de-facto standard of face detection in real-world applications since [2].

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Even do the issue of the actual mechanism for the visual and computational perception of motion in the human are kept grow for the last decade. Each reseacrher are keep pursuit to find the ideal algorithm of the robust recognition and detection of video system. However most of the system just able to record the scenario of the event in certain location [4], without further analysis.

There are a lot researches have been done to detect the movement of the object in the consicutive frame. However, the objective only to detect the motion of the object in the frame image. Most of the camera can detect the movement of the object; however it still difficult to classify either the object is unliving object, human or animal [5].

The rest of the paper is organized as follows. Section 2 gives an overview of the System face detector, which also motivates many of the recent advances in face detection. Solutions to two key issues for face detection: what features to extract, and which learning algorithm to apply, will be brief in Section 3 (feature extraction), Section 4 stand for Result and Discussion. Conclusions and future work are given in Section 5.

2. Method

The complete block diagram representation of the proposed system is as shown in Figure 1. After inputting a facial image, a PCA based algorithm is applied to detect the infant face in the image [6-8]. The face images used in this work have been provided by the Computer Vision Laboratory, University of Ljubljana, Slovenia [9-10] with different illumination levels. The feature extraction of the eyes and mouth of the image are cropped from the face. The conditions of the infant were determined based on Mean, Variance, Skewness and Kurtosis. All the codes are written in MATLAB software.

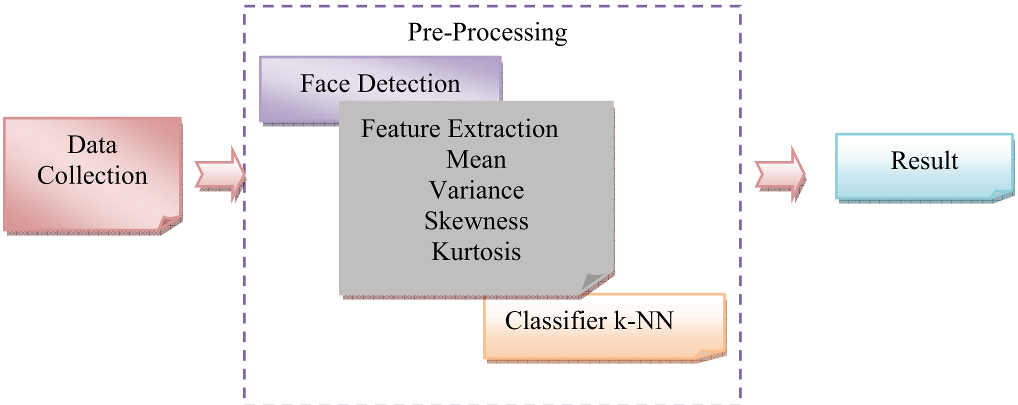

Figure 1. Block diagram

3. Face Detection

Over the past few years, several face recognition systems have been proposed based on principal components analysis (PCA) [6-8]. Although the details vary, these systems can all be described in terms of the same preprocessing and run-time steps. During preprocessing, they register a gallery of m training images to each other and unroll each image into a vector of n pixel values. Next, the mean image for the gallery is subtracted from each and the resulting "centered" images are placed in a gallery matrix M. Element $[i; j]$ of M is the ith pixel from the jth image.

A covariance matrix W = MMT characterizes the distribution of the m images in Ân. A subset of the Eigenvectors of W is used as the basis vectors for a subspace in which to compare gallery and novel probe images. When sorted by decreasing Eigenvalue, the full set of unit length Eigenvectors represent an orthonormal basis where the first direction corresponds to the direction of maximum variance in the images, the second the next largest variance, etc. These basis vectors are the Principle Components of the gallery images. Once the Eigenspace is computed, the centered gallery images are projected into this subspace. At run-time, recognition is accomplished by projecting a centered probe image into the subspace and the nearest gallery image to the probe image is selected as its match.

3.1. Feature Extraction

When a set of values has a sufficiently strong central tendency, that is, a tendency to cluster around some particular value, then it may be useful to characterize the set by a few numbers that are related to its *moments*, the sums of integer powers of the values. Best known is the *mean* μ of the values $\mu_1 \ldots \mu_N$,

$$\text{Where } P_K = \frac{h_K}{\sum_{K=1}^{K} h_K} \tag{1}$$

$$mean = \mu = \sum_{k=1}^{K} kP_K \tag{2}$$

Which estimates the value around which central clustering occurs. Note the use of an overbar to denote the mean; angle brackets are an equally common notation, e.g., μ.

Having characterized a distribution’s central value, one conventionally next characterizes its “width” or “variability” around that value. Here again, more than one measure is available. Most common is the *variance*,

$$Variance = \sigma = \sum_{k=1}^{K} (k-\mu)^2 P_K \tag{3}$$

The skewness characterizes the degree of asymmetry of a distribution around its mean. While the mean, standard deviation, and average deviation are *dimensional* quantities, that is, have the same units as the measured quantities μ *j,* the skewness is conventionally defined in such a way as to make it *nondimensional*. It is a pure number that characterizes only the shape of the distribution. The usual definition is

$$Skewness = \tau_3 = \frac{1}{\sigma^3} \sum_{k=1}^{K} (k-\mu)^3 P_K \tag{4}$$

where $\sigma = \sigma(\mu_1 \ldots \mu_N)$ is the distribution’s standard deviation. A positive value of skewness signifies a distribution with an asymmetric tail extending out towards more positive μ; a negative value signifies a distribution whose tail extends out towards more negative.

The kurtosis is also a nondimensional quantity. It measures the relative peakedness or flatness of a distribution. Relative to a normal distribution, a distribution with positive kurtosis is termed *leptokurtic*; the outline of the Matterhorn is an example. A distribution with negative kurtosis is termed *platykurtic*. The conventional definition of the kurtosis is

$$Kurtosis = \tau_4 = \frac{1}{\sigma^4} \sum_{k=1}^{K} (k-\mu)^4 P_K - 3 \tag{5}$$

3.2. k-NN Classifier

K-nearest neighbor (k-NN) is a simple classification model that exploits lazy learning [11]. It is a supervised learning algorithm by classifying the new instances query based on majority of k-nearest neighbor category. Minimum distance between query instance and the training samples is calculated to determine the k-NN category. The k-NN prediction of the query instance is determined based on majority voting of the nearest neighbor category. Since query instance (test signal) will compare against all training signal, k-NN encounters high response time [11].

In this works, for each test signal (to be predicted), minimum distance from the test signal to the training set is calculated to locate the k-NN category of the training data set. A Euclidean Distance measure is used to calculate how close each member of the training set is to the test class that is being examined. Euclidean Distance measuring:

$$d_E(x,y) = \sum_{i=1}^{N} \sqrt{x_i^2 - y_i^2} \tag{6}$$

From this k-NN category, class label of the test signal is determined by applying majority voting.

4. Result and Discussion

The proposed algorithm was evaluated on a 267 subjects with different race, gender and age. The average size of each image is 400-500 pixels. The entire subjects were tested for ten trials. Ten images were taken for each subject. Average accuracy for all subjects was shown in Figure 1.

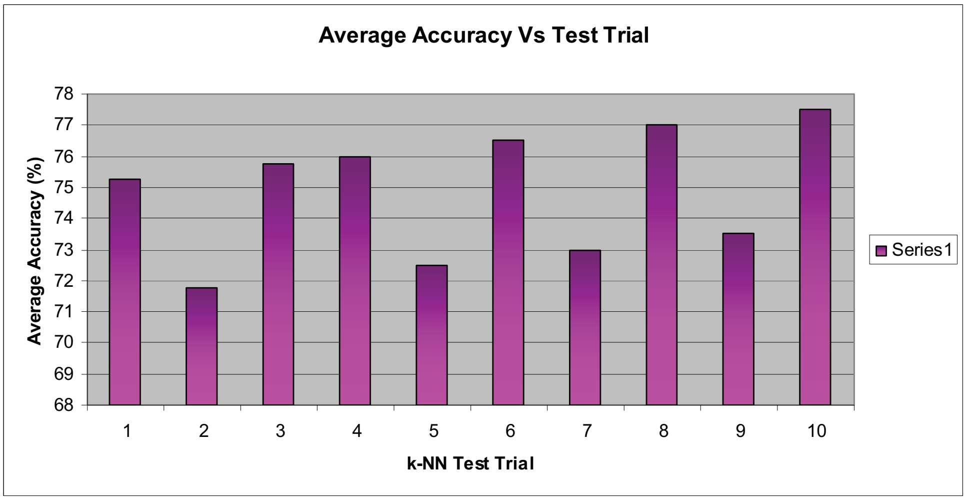

Figure 1. Accuracy versus different Test Trial

The confidence values for the recognition of a person is calculated using the Euclidean distance between the PCA projected values of the test image and PCA projected values of the train database. This value determines whether recognition of a face image using this method is dependable or not. When the confidence value is low recognition is not dependable. The confidence value obtained for different test images are 77.50% in Figure 1.

5. Conclusion

The proposed security system based on k-nn Classifier localizes the face from the given input image using the PCA method where employed. The detected face image is projected using Eigen face analysis and classified using the K nearest neighborhood (KNN) classifier. This algorithm is efficient as it can be integrated with the output from multi-modal sensors and thus can be used as part of multi-sensor data fusion

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Reference

1. Erik Hjelmas, "Face Detection: A Survey," Computer Vision and Image Understanding Vol 83**,** 236–274 (2001)
2. P. Viola and M. Jones. Rapid object detection using a boosted cascade of simple features. In *Proc. of CVPR*,2001.
3. M.-H. Yang, D. J. Kriegman, and N. Ahuja. Detecting faces in images: A survey. *IEEE Trans. on PAMI*, 24(1):34–58, 2002.
4. T.C Robert, J.L Alan, and K. Takeo, "Introduction to the Special Edition on Video Surveillance", Proceedings of the IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume 22, No. 8, pp 745-757, August 2000.
5. N. Dalal and B. Triggs, "Histograms of oriented gradients for human.Detection", Proceedings of the Conference on Computer Vision and Pattern Recognition, San Diego, California, USA, pp. 886–893, 2005.
6. D. Swets and J. Weng. Using discrimant eigenfeatures for image retrieval. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 18(8):831–836, 1996.
7. D. Swets and J. Weng. Hierarchical discriminant analysis for image retrieval. IEEE Transactions on Pattern Analysis and Machine Intelligence, 21(5):386–401, 1999.
8. Analysis of PCA-Based and Fisher Discriminant-Based Image Recognition Algorithms, Wendy S. Yambor, M.S. Thesis, July 2000 (Technical Report CS-00-103, Computer Science).
9. Peter Peer, CVL Face Database: http://www.lrv.fri.uni-lj.si/facedb.html
10. Franc Solina, Peter Peer, Borut Batagelj, Samo Juvan, Jure Kovač, "Color-based face detection in the '15 seconds of fame' art installation", In: Mirage 2003, Conference on Computer Vision / Computer Graphics Collaboration for Model-based Imaging, Rendering, image Analysis and Graphical special Effects, March 10-11 2003, INRIA Rocquencourt, France, Wilfried Philips, Rocquencourt, INRIA, 2003, pp. 38-47.
11. Mansor MN, Yaacob S, Nagarajan R, Muthusamy H: "Coma Patients Expression Analysis under Different Lighting using k-NN and LDA." International Journal of Signal and Image Processing (IJSIP), Vol 1, No 4, pp, 249-254, Hyper Sciences, (2010)